

DEVELOPMENT OF A FLOOD-ANALYSIS MODEL FOR THE DELAWARE RIVER

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Abstract

Major flooding occurred in the Delaware River in September 2004, April 2005, and June 2006. Four reservoirs in the watershed are managed for flood-loss reduction by U.S. Army Corps of Engineers (USACE), and other reservoirs – designed and used primarily for water supply, recreation, low-flow augmentation, or hydropower – also attenuate streamflow. To evaluate the impact of reservoir levels and other factors on peak streamflow, the Delaware River Basin Commission (DRBC), U.S. Geological Survey (USGS), USACE Hydrologic Engineering Center (HEC), and National Oceanic and Atmospheric Administration's National Weather Service (NWS) developed a Delaware River Flood-Analysis Model (DelRivFAM). The States of Delaware, Pennsylvania, New Jersey, and New York provided support for development of DelRivFAM, as part of a larger project, through DRBC. The model area is the 6,780 square-mile watershed of the Delaware River in the States of New York, New Jersey, and Pennsylvania that drains to the USGS streamflow gage at Trenton, N.J.

DelRivFAM software includes hydrologic modeling tools from multiple agencies. Precipitation Runoff Modeling System (PRMS) from USGS simulates reservoir inflow and runoff throughout the watershed. PRMS also routes streamflow in tributaries above simulated reservoirs. HEC-ResSim from USACE simulates the operations of thirteen reservoirs in the watershed and routes streamflow below the reservoirs. NWS provided data and processing algorithms for the radar-based Multisensor Precipitation Estimate (MPE) for 2001-2007, as well as code and parameters for “Variable lag & K” streamflow routing, from NWS' River Forecast System (NWSRFS). USGS ported the NWSRFS Snow-17 module to PRMS for hourly snow accumulation and ablation.

PRMS uses a daily time step for simulation of antecedent conditions, and switches to hourly time steps during the three highflow events. Daily and hourly precipitation for the model was downscaled from NWS MPE data. The model was calibrated for the three highflow events using automatic and manual procedures, and hourly streamflow data from 35 USGS streamflow-gaging stations.

HEC-ResSim models releases from thirteen reservoirs, based on reservoir operation information provided by DRBC, USACE Philadelphia District, New York City Department of Environmental Protection, and private reservoir operators. HEC-ResSim routes flow downstream of the major reservoirs using “Variable lag&K” and Muskingum routing. Flow-routing parameters were

calibrated using streamflow and reservoir operations data. In addition to using PRMS-modeled runoff, HEC-ResSim can use a “gage-estimate” time series combining observed unregulated streamflow where available with estimates of ungaged runoff generated by translation and scaling of hydrographs from nearby gages. This option provides results that very closely match observed streamflow downstream from simulated reservoirs, but is limited to analysis of the actual events with existing conditions.

DelRivFAM is a planning tool for simulation of runoff and streamflow throughout the mainstem subbasin of the Delaware River, and for evaluation of alternative reservoir management on streamflow during floods. DelRivFAM can also simulate the effects of other changes to the reservoir system, or changes to conditions such as impervious surface in the watershed or different climate.

More Information

- Delaware River Basin Commission, 2010, Delaware River Basin Flood Analysis Model Project: accessed February 25, 2010, at http://www.state.nj.us/drbc/Flood_Website/FloodAnalysisModel/ .
- Goode, D.J., Koerkle, E.H., Hoffman, S.A., Regan, R.S., Hay, L.E., and Markstrom, S.L., 2010, Simulation of runoff and reservoir inflow for use in a flood-analysis model for the Delaware River, Pennsylvania, New Jersey, and New York, 2004-2006: U.S. Geological Survey Open-File Report 2010-1014, 68 p. (<http://pubs.usgs.gov/of/2010/1014/>)
- Hydrologic Engineering Center, 2010, Delaware River Basin Flood Analysis Model, Reservoir Operations and Streamflow Routing Component: U.S. Army Corps of Engineers, Hydrologic Engineering Center, Project Report PR-73, 219 p. (<http://www.hec.usace.army.mil/publications/ProjectReports/PR-73.pdf>)